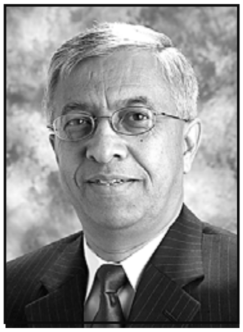
Recent News of Interest

GEWEX Welcomes New Director of WCRP Joint Planning Staff



Dr. Ghassem R. Asrar served as the Deputy Administrator for Natural Resources and Agricultural Systems with the Agricultural Research Service of the U.S. Department of Agriculture from 2006–2008. He was appointed to this position after 20 years of service with the U.S. National Aeronautics and Space Administration (NASA), where he served as Chief Scientist for the Earth Observing System in the Office of Earth Science at NASA Headquarters prior to being named as the Associate Administrator for Earth Science in 1998. For more information about Dr. Asrar, see *http://wcrp.wmo.int/documents/WCRPnews_20080221_Asrar.pdf*.

LANDSAT Imagery for Everyone

The U.S. Geological Survey (USGS) Landsat 35-year record of the Earth's surface will soon be available to users at no charge. Under a transition toward a National Land Imaging Program sponsored by the Secretary of the Interior, the USGS is pursuing an aggressive schedule to provide users with electronic access to any Landsat scene held in the USGS-managed national archive of global scenes dating back to Landsat 1, launched in 1972. By February 2009, any Landsat archive scene selected by a user will be automatically processed, at no charge, to a standard product recipe and staged for electronic retrieval. In addition, newly acquired scenes meeting a cloud cover threshold of 20 percent or below will be processed to the standard recipe and placed online for at least 3 months, after which they will remain available for selection from the archive. For details see *http://landsat.usgs.gov*.

Pierre Morel Honored at European Geophysical Union Meeting

Pierre Morel was awarded the EGU Alfred Wegener Medal for his outstanding contributions to geophysical fluid dynamics and his leadership in the development of climate research and the applications of space observation to meteorology and Earth system science. Throughout his 40-year career, Dr. Morel was one of the most active scientists initiating and developing tools and international programs for meteorological and climatic research. From 1982 to 1994, as Director of the World Climate Research Programme, he steered a broad interdisciplinary research program in global climate and Earth system science, involving the participation of atmospheric, oceanic, hydrological, and polar scientists worldwide.

GCSS Stratocumulus Large-Eddy Simulation Intercomparisons Targeting Climate Model Uncertainties

A. S. Ackerman
NASA Goddard Institute for Space Studies
New York, NY, USA

Marine boundary-layer clouds exert a substantial short-wave radiative forcing on the global heat budget. Due to problems in representing these clouds in general circulation models, they contribute a leading-order uncertainty in cloud feedbacks in global climate models (Bony and Dufresne, 2005).

The GEWEX Cloud System Study (GCSS) Boundary Layer Cloud Working Group (BLCWG) has conducted a number of workshops devoted to idealized case studies of low-lying clouds simulated with a range of models. The BLCWG intercomparison of large-eddy simulations (LES) focused on the first research flight of the Dynamics and Chemistry of Marine Stratocumulus Phase II (DYCOMS-II) field project in which very dry air overlays a stratocumulus-topped marine boundary layer with no measurable precipitation below the cloud base (Stevens et al., 2005a). Models that reduced subgrid-scale mixing at the cloud top were found best able to maintain sufficient radiative cooling while concurrently limiting entrainment at the cloud top, resulting in a well-mixed boundary layer topped by an optically thick cloud layer. Cloud-water sedimentation and drizzle were ignored in those simulations, as is traditional in studies of non-precipitating clouds.

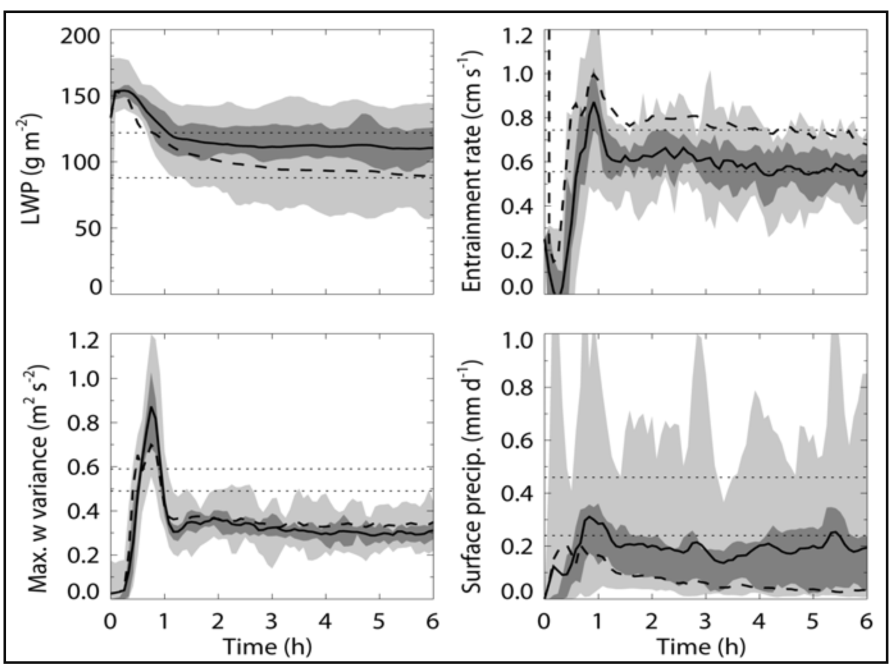
While the importance of drizzle on the stratocumulus-topped boundary layer has been long acknowledged, only recently has the significance of cloud-water sedimentation been recognized in large-eddy simulations of stratocumulus (Ackerman et al., 2004; Bretherton et al., 2007). The BLCWG workshop focused on the roles of cloud-water sedimentation and drizzle in a final ensemble of eleven LES models, two of which used bin microphysics while the rest used parameterized cloud microphysics. The simulation specifications were based on an idealization of the second research flight of DYCOMS-II, which sampled a bimodal cloud population with pockets of heavily drizzling open cells among a deck of closed-cell stratocumulus that was drizzling lightly (vanZanten and Stevens, 2005; Stevens et al., 2005b; Petters et al., 2006). Six-hour simulations were run with and without drizzle, each with and without cloud-water sedimentation. Highlights of the results are presented here (a paper describing the results and implications has been provisionally accepted for publication in *Monthly Weather Review* and is available upon request from the author). The BLCWG has also compared single-column models using the same specifications developed for the LES intercomparison, as described by Wyant et al. (2007).

The air overlying the boundary layer is slightly cooler and moister in this case compared to that in the previous intercomparison (Stevens et al., 2005b), which evidently allowed the model ensemble to do a much better job of reproducing the observed entrainment rate and liquid water path (LWP). For example, LWP varied by less than a factor of two among the models, whereas LWP varied by more than an order of magnitude among the models in the previous case. This improvement in model agreement does not require cloud-water sedimentation or drizzle (which were not considered in the previous intercomparison), as the ensemble ranges of LWP are comparable both with and without those processes.

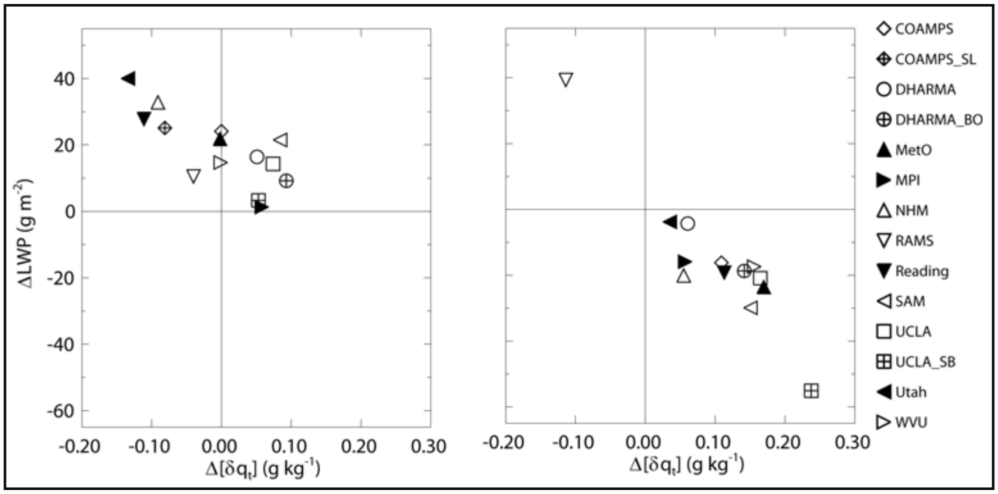
Time series characterizing the ensemble of simulations with cloud-water sedimentation and drizzle are compared with the observations found in the figure below. After a transient spin-up of boundary-layer convection, the ensemble settles into a quasi-steady state in which the mean LWP reproduces the observed mean LWP remarkably well, while the mean entrainment rate is at the lower end of the observations and the ensemble-average maximum vertical wind variance is roughly half of that measured. On average, precipitation at the surface and at the cloud base is smaller, and the rate of evaporation greater than measured. Comparison of the simulated and measured profiles provides further evidence that the simulated boundary layers are not as well mixed as in the observations.

An indicator of the structure of the turbulent mixing—the mean third moment of *w,* the vertical wind—was observed to be negative near the cloud base, indicating downdrafts stronger than updrafts. In contrast, the skewness of *w* was positive near the cloud base in the simulations. Cloud-water sedimentation leads to an increase in the third moment of *w* near the cloud base for all the simulations with drizzle; thus the apparent disagreement between the measured and simulated third moment of *w* can be attributed to this process. Unfortunately the strength of this process was exaggerated by roughly a factor of two in the models that parameterize cloud microphysics (the specified breadth of the cloud droplet size distribution was broader than measured, in retrospect), thus amplifying its impact in the majority of simulations.

Sedimentation of cloud water was found to consistently result in decreased entrainment and increased LWP, as found in other recent studies that have considered the role of this process; however, there are some differences with previous findings. For instance, Bretherton et al. (2007) considered the conditions from the first research flight of DYCOMS-II and found that convective intensity (as measured by the variance of *w*) increased throughout the bulk of the boundary layer in response to cloud-water sedimentation reducing entrainment. In this intercomparison, which considered a much thicker cloud layer with less than half the droplet concentration—factors that together enhance the parameterized cloud-water sedimentation flux by up to a factor of five, cloud-water sedimentation was instead found to reduce convective intensity in most of the models. A sensitivity test with one of the models, in which drizzle is omitted and cloud-water sedimentation is parameterized, shows that this reduction of convective intensity nearly vanishes when the strength of cloud-water sedimentation is halved. The stronger cloud-water sedimentation results in a marked increase in the volume of unsaturated air within the cloud layer, most pronounced near the cloud base. Thus, the evidence suggests that strong cloud-top sedimentation flux divergence of cloud water not only reduces the efficiency of entrainment—as found by Bretherton et al. (2007)—but also can result in dry, buoyant, and energetically unfavorable downdrafts above the mean cloud base, as found by Stevens et al. (1998) in simulations of heavily drizzling stratocumulus.



Evolution of domain average liquid water path (LWP), entrainment rate, maximum variance of vertical wind, and surface precipitation for simulations that include cloud-water sedimentation and drizzle. The ensemble range, middle two quartiles, and mean are denoted by light and dark shading and solid lines, respectively. Ensemble mean from simulations that include drizzle but not cloud-water sedimentation are denoted by dashed lines. Approximate ranges of measurement averages are denoted by dotted lines.



Change of LWP versus change of difference in total water mixing ratio between the sub-cloud and cloud layers of (äq_t) associated with cloud-water sedimentation (left) and drizzle (right), averaged over last 4 hours of simulations. Drizzle is included in simulations on the left, and cloud-water sedimentation is included in simulations on the right.

Turning from the effects of cloud-water sedimentation to those of drizzle (as models with bin microphysics make no distinction between cloud droplets and drizzle drops, a radius cutoff of 25 µm was used in the analysis), LWP was found to decrease in response to drizzle in all but one of the models, despite a very slight reduction in entrainment. Thus, while the effects of cloud-water sedimentation and drizzle conspire with respect to entrainment, their effects on LWP are opposed for all but one of the models, as seen in the figure above. Taken together, the effect of cloud-water sedimentation on LWP dominates in all but two cases. That is, the inclusion of both processes results in a net LWP increase in nearly all the models. However, drizzle is not that strong in the simulations, and cloud-water sedimentation is exaggerated relative to the observations in the models that parameterized it.

The changes in LWP and the vertical gradient of total water mixing ratio (i.e., vapor plus condensate) are strongly correlated in response to cloud-water sedimentation or drizzle, as seen above. The trend is also strong when considering the effect of both processes combined. Drizzle is thus seen to increase boundary-layer stratification in all but one of the models, while the effect of cloud-water sedimentation on stratification is more varied within the ensemble, with stratification decreasing in nearly as many models as those in which it increases.

In summary, the results here reinforce recent findings regarding the importance of cloud-water sedimentation to boundary-layer entrainment (and thereby cloud liquid water path), in this case reducing the entrainment rate by approximately 25 percent or more (with or without drizzle included). It was also found that differences in model dynamics dominate the spread in entrainment rates, which is of the same order as the changes in entrainment rates induced by cloud-water sedimentation. Models that entrain rapidly with microphysics omitted tended to entrain rapidly with microphysics included.

Acknowledgements

Thanks to M. C. vanZanten (KNMI), B. Stevens (UCLA), V. Savic-Jovcic (UCLA), C. S. Bretherton (U. Washington), A. Chlond (MPI), J.-C. Golaz (NOAA-GFDL), H. Jiang (NOAA-ESRL), M. Khairoutdinov (Stony Brook U.), S. K. Krueger (U. Utah), D. C. Lewellen (West Virginia U.), A. Lock (MetO), C.-H. Moeng (NCAR), K. Nakamura (JAMSTEC), M. D. Petters (Colorado State U.), J. R. Snider (U. Wyoming), S. Weinbrecht (U. Reading), and M. Zulauf (U. Utah) for participating in the intercomparison.

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